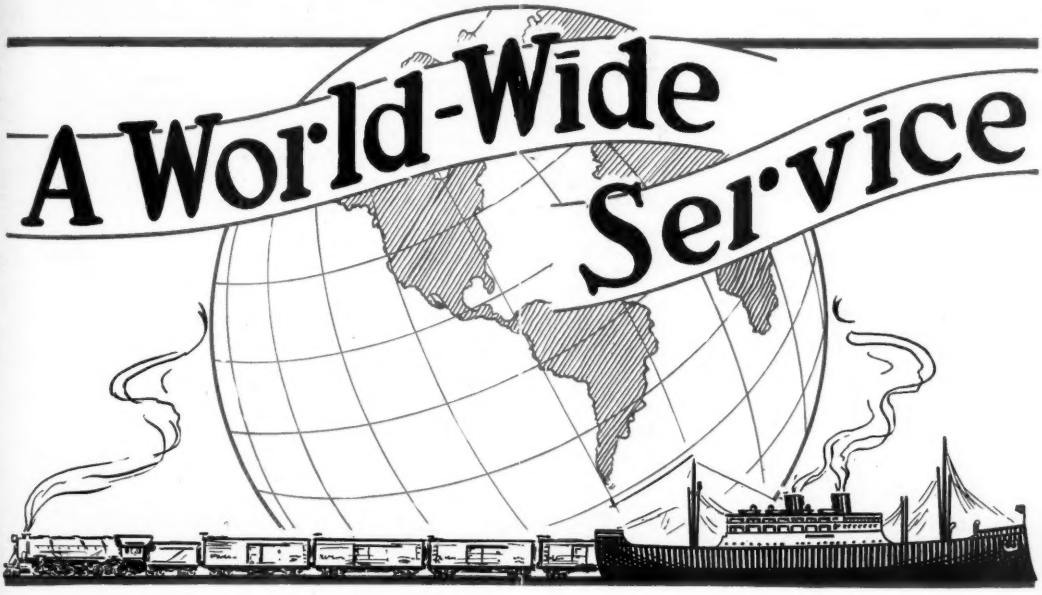
The American Fertilizer

Vol. 93 OCTOBER 12, 1940 No. 8



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-- DECEMBER 1930 --

Number 5.

SOIL STUDIES

Extracted from the 51st Annual Report of the North Carolina Agricultural Experiment Station
Pp. 53-55. December 1, 1928 (1929)

Soil Deficiencies. A new prerequisite in research on soil chemistry [illegible] has been introduced by evidences of a widespread boron deficiency in the state. This becomes acute in west currents of boron deficiency in the state. This becomes acute in west instances only when lime is applied, but on the other hand the boron problem becomes a dominant factor in all liming experiments.

During the progress of the experimental work it has been found necessary to proceed on the basis of certain assumptions or theories the accuracy of which may not be definitely established. Objective tests of these theories in the field have yielded evidences that bear will in some degree control the magnesium deficiency. Work now in progress is designed to test the further assumption that the boron problem is relative to the concentration or to a hypothetical activity of calcium in the soil and that this balance modifies in significant degree the functional effects of plant nutrients.

[illegible] has been obtained on this subject the [illegible] agreed with the boron studies.

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See Page 25

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Vol. 93 OCTOBER 12, 1940 No. 8

Availability of Phosphates*

What the More Recent Literature Discloses and What It Lacks

By ARTHUR M. SMITH

Vice-President and Technical Director, Synthetic Nitrogen Products Corporation, New York, N. Y.

THE availability of the mineral phosphorus compounds in fertilizers is a matter of great importance to farmers and to fertilizer manufacturers. The extent of the published experimental work shows that scientists have realized the importance of the problem; and the many different methods of attack they have employed portray the intricacies of the various factors involved.

In general, chemists seem to have made more progress in the study of the availability of phosphorus than the agronomists or horticulturists. Possibly this is because the fundamentals lie in the fields of soil physics and chemistry and plant physiology. It appears safe to say that many, if not most, of the basic principles governing the "availability," or solubility, absorption and assimilation of phosphorus by plants are now understood. The practical application of these principles to economic farm operations, however, has not been so generally developed and demonstrated by agronomists and horticulturists; nor have they in most states experimented in the field with the forms and compositions of phosphorus materials to the extent that they have with the various nitrogen and potash materials. Possibly the producers of phosphates have not been sufficiently aggressive in pushing for closer and more extensive cooperation.

It is worth while to present some of the generally accepted information that is now in the published literature.

H-Ion Concentration and Lime

With reference to hydrogen ion concentration and lime, the range of highest availability of applied phosphorus seems to be in soils of pH 5.0 to 6.0. The availability generally decreases rapidly below pH 5.0, and is very low at pH 7.5 or higher when calcium is the predominant alkali. Added lime decreases the rate of availability of rock phosphate but tends to prevent undue fixation of added soluble phosphates and of the native phosphorus of the soil. In some calcareous soils phosphorus is precipitated at as low a pH as 5.5.

In some sections, as for example in Hawaii, added phosphorus gives a response on acid soils but no response on neutral soils since iron is precipitated and an iron deficiency results.

Solubility, Equilibrium and Residual Effect

It has been generally shown that the fixation or reversion of soluble phosphates is accomplished by soluble iron and aluminum compounds and the colloidal silicates of these elements. In soils of high fixing power and with sufficient moisture this is accomplished within 24 to 48 hours after application. In such soils it has been generally shown that phosphorus in the water-soluble combination is reverted more rapidly than when the less soluble forms are applied. As usual, experiments conducted under extreme conditions have pointed out the method of approach to the problem under less extreme conditions.

In acid soils di-calcium phosphate seems to be slightly more available than mono-calcium phosphate, and in most soils of pH 5.0 to 7.0 superphosphate seems to average a slightly higher availability to most crops than either mono- or di-calcium phosphate; the explanation suggested by the research workers being the influence of the small quantity of magnesium and of the sulphur it contains.

* A paper presented at the Meeting of the Division of Fertilizer Chemistry, American Chemical Society, Detroit, Mich., September 9-13, 1940.

It has been found that the penetration of soils by superphosphate may be increased by the addition of the nitrates or sulphates of sodium, potassium, ammonium or magnesium; and that sodium, ammonium and potassium phosphates, and certain organic phosphates such as the glycerol phosphates, penetrate most soils more readily than does superphosphate. Of course, the extent of penetration is greater in the light sandy soils than in soils high in colloidal clay or organic matter. Dependent on the ratio SiO_2/R_2O_3, and the concentration of calcium or hydrogen ions, this deeper penetration may or may not result in an appreciably greater fixation.

Soluble phosphates applied to pastures seem to move downward into the soil very slowly, indicating the inefficiency of surface application. On the other hand, when soluble phosphates have been placed several inches below the surface in soils of low fixing power, a tendency for soluble phosphorus to rise to the surface has been observed.

Long continued fertilization with superphosphate seems to have had little effect in satisfying the phosphorus absorption power of soils high in mineral colloids, while a relatively few heavy annual applications seem to satisfy it almost completely on sandy soils low in iron and aluminum in humid sections, thereby enabling most of the phosphorus in later applications to remain in a highly available form.

In general, the application of soluble phosphates tends to precipitate soluble aluminum, and thereby destroy its toxic properties; but the economic gain in using soluble phosphates for this purpose instead of the lower cost basic phosphates or one of the liming materials is not evident.

Chemical Analysis of Soils

The chemist has contributed much through the development of methods of analysis. While the results of analyses for the total amounts of plant-food in the soil seem at present relegated to the status of background material for reference purposes and the long-time inventory of soil types, the so-called "quick soil tests" or methods for easily soluble plant-food have, with competent interpretation, proved valuable as a guide in diagnosing fertility problems.

The choice of extracting solvents is apparently dependent on the predominating acidic or alkaline elements in the soil complex; and the interpretations of the data must be made by persons fully acquainted with the physiology of the crops grown in the rotation and the economics of the farmers pocketbook. Complete agreement on methods has not been attained, and much progress can be expected within the next few years; but the evidence in the literature at present leaves little if any cause for complaint as to the progress made.

Phosphoric acid is present in soils mostly in slightly soluble combinations, and the concentration in the soil solution is never high. Plants have a selective action in the absorption of nutrients and can probably take up ions as well as elements. No single chemical agent can ever imitate these effects of plants on soils. There is an inter-relation between the surpluses, sufficiencies, and deficiencies of each of the essential plant-food elements that is difficult to gauge even from the results of carefully conducted tests. A marked change in the soil moisture content of the soil towards the optimum from either a deficiency or an excess, is known to affect the P_2O_5 absorption and assimilation of crops. A test of the soil some time after the phosphate has been added cannot show the soil condition with which the plants had to contend at the start. This seems to indicate that constant tests should be made when field plots are used in research work on phosphate availability.

Biological Methods

Soil biologists have contributed something in studying the effect of applied phosphates on the growth curve of such organisms as *Aspergillus niger*. These studies have proved useful as a corollary check against the data obtained by the rapid tests for easily soluble phosphorus.

Soil-sand cultures to which phosphorus materials have been applied in varying quantities and seeds planted therein, as for example the Neubauer test, have developed reliable and useful data. From such studies when neutral sand is used it has been found that the availability of the phosphorus in the water-soluble phosphates, superphosphate and di-calcium phosphate is similar to that indicated by the present "Official Method" for determining available P_2O_5; but that a lesser degree of availability is shown for tri-calcium phosphate, limed superphosphate, highly ammoniated superphosphate, and basic slag. When an acid soil was used, the indicated availabilities of these materials were approximately equal to mono-calcium phosphate; while those for rock phosphate, bone ash, iron and aluminum phosphate and fluor-spar basic-slag were considerably lower.

Experiments have shown that heating the soil usually increased the quantity of phosphates

(Continued on page 24)

New and Old Methods of Processing Phosphate*

By K. D. JACOB

Division of Fertilizer Research, Bureau of Plant Industry, Washington, D. C.

IN 1939 the United States, including Hawaii and Puerto Rico, consumed 7,738,769 short tons of all kinds of commercial fertilizers, containing 390,034 tons of nitrogen, 709,645 tons of available phosphoric oxide (P_2O_5) and 404,738 tons of potassium oxide (K_2O).[1] These figures seem to support the oft-repeated statement that the domestic consumption of phosphatic fertilizer far exceeds the consumption of either nitrogenous or potassic fertilizer. If, however, the consumption of phosphatic and potassic fertilizers, like that of nitrogenous fertilizer, is calculated on the basis of the elements, the logical basis for comparison, the picture of the situation is quite different. On this basis the 1939 figures are 390,034, 309,732 and 335,985 tons of nitrogen, phosphorus and potassium, respectively. Thus, in terms of the elements, the consumption of commercial phosphatic fertilizer was actually lower than that of either nitrogenous or potassic fertilizer.

As a matter of fact, for a number of years the trend has been toward a decrease in the consumption of phosphorus relative to that of nitrogen and potassium. Although a discussion of the reasons for this is not within the scope of this paper, it may be mentioned that during the last fifteen years there has been a marked decrease in the costs of nitrogenous and potassic materials, whereas the cost of phosphate has undergone little change. It should be borne in mind, however, that almost from the beginning of the chemical fertilizer industry this country has been not only self-sufficient in phosphate but a large exporter of this material, while until recently we were dependent on foreign sources for much of our nitrogen and nearly all of our potash.

Evaluation and Classification of Phosphates

In the initial years of the commercial fertilizer industry, phosphates were classified broadly into two groups comprising the water-soluble phosphates on the one hand and the water-insoluble phosphates on the other. Materials of the first group were considered to be, and usually are, excellent sources of phosphorus for plant growth, whereas those of the second group were thought to be slower in action and less efficient. It was soon demonstrated, however, that a distinction between good and poor sources of phosphorus cannot be made solely on the basis of solubility in water, and the need for a laboratory method for evaluating water-insoluble phosphates led Fresenius, Neubauer and Luck[2] to propose, in 1871, the use of ammonium citrate solution for this purpose. A modification of the method of Fresenius, Neubauer and Luck was adopted by the Association of Official Agricultural Chemists at its first meeting in 1884,[3] and this method with minor changes still serves as the official laboratory procedure for determining the availability of all water-insoluble phosphates, except basic slag. Although basic slag is universally evaluated by means of Wagner's citric acid method, ammonium citrate is also an excellent solvent for the phosphorus of this material.

Obviously, any chemical laboratory method for determining the fertilizing value of a phosphate can be nothing more than an empirical procedure, and its usefulness depends solely upon the degree of correlation between the laboratory result and the average efficiency of the phosphate in promoting plant growth under a wide variety of conditions of soil, climate, farm management, etc. Continued work in both the laboratory and field is essential for the improvement of this correlation.

The neutral ammonium citrate method, as now used in this country, is based on nearly 75 years of study and experimentation, and it has served an extremely useful purpose in fertilizer research and in the administration of fertilizer control laws. Despite this fact and contrary to the opinion that seems to prevail in some quarters, neither this method nor any other laboratory method gives or can be expected to give anything but a general appraisal of the fertilizing value of a phosphate or a mixture of phosphates. Under practical farming conditions the value of any phosphate in relation to that of another may, and often does, vary widely in different sections of the country and even on

* Presented before the Western Phosphate Conference, Ogden, Utah, September 5 and 6, 1940.

[1] Mehring, A. L., and Deming, L. S., Am. Fertilizer **93**, No. 4, 5-11, 22, 24, 26 (1940).

[2] Z. anal. Chem. **10**, 133-58 (1871).

[3] Proc. Assoc. Official Agr. Chem., 1884, p. 4.

different farms in the same section. Nevertheless, it has been demonstrated conclusively that citrate solubility is an index of the fertilizing value of water-insoluble phosphates under the conditions that prevail generally in the principal farming regions of this country.

On the basis of their solubilities in water and neutral ammonium citrate solution, phosphates can be classified conveniently into three groups, namely, (1) those readily soluble in water, (2) those practically insoluble in water but largely or completely soluble in ammonium citrate, and (3) those insoluble in water and only slightly soluble in ammonium citrate.

The water-soluble phosphate fertilizers comprise the ordinary and double superphosphates, of which monocalcium phosphate is the principal phosphatic component, the monoammonium and diammonium phosphates, and monopotassium phosphate. This group also includes many organic phosphates, some of which, for example, the glycerophosphates and hexose phosphates, are excellent sources of phosphorus for plants.

The citrate-soluble phosphate fertilizers comprise dicalcium phosphate (commonly called precipitated phosphate or precipitated bone), basic slag, the calcium and potassium metaphosphates, the defluorinated phosphates (calcined phosphate and fused phosphate rock), precipitated iron and aluminum phosphates, and certain products, such as the German-made Rhenania phosphate, obtained by heating phosphate rock with alkali carbonates or sulphates.

Although bone meal and precipitated tricalcium phosphate can be included in this group, different samples of these materials may show wide variations in their solubilities. It appears, in general, that approximately 50 per cent of the phosphorus in bone meal is soluble in neutral ammonium citrate solution by the official method of analysis. The solubility of the phosphorus of tricalcium phosphate depends markedly on the conditions under which the material is precipitated and subsequently dried; usually the solubility is about 50 per cent, although in some samples it is as high as 75 per cent.

Raw mineral phosphate is the principal member of the third group of materials, namely, those insoluble in water and only slightly soluble in ammonium citrate solution. Beside phosphate rock, this member includes the so-called soft phosphate, which is a natural finely divided material produced in Florida and sold under such names as Colloidal Phosphate, Calphos, Mineral Colloids and PhosCalOids. The phosphorus of South Carolina rock is 15 to 20 per cent soluble in ammonium citrate solution, whereas that of the other domestic types of natural phosphates is usually only 5 to 10 per cent soluble.

Ordinary Superphosphate

Domestic production of chemical fertilizers was started about 1850 in Baltimore, and, from the beginning, the manufacture of ordinary superphosphate, which consists of approximately equal weights of monocalcium phosphate and calcium sulphate and contains up to about 22 per cent of P_2O_5, has been the backbone of the industry. The production of this material has increased from about 31,000 short tons in 1868, the year in which active exploitation of the South Carolina phosphate deposits began, to about 3,500,000 tons now manufactured by approximately 160 plants in 22 states.

Although it is frequently said there has been little or no technical progress in the manufacture of superphosphate for many years, the facts do not justify this statement. For example, the average content of available P_2O_5 in ordinary superphosphate has gradually increased from 11.01 per cent in 1880 to 18.89 per cent in 1939.[4] While this increase is partly the result of the use of better grades of phosphate rock and the elimination of "filler" from the superphosphate, improvements in the manufacturing operation, whereby a drier product and a higher yield of available P_2O_5 are obtained, are an important factor.

In the earlier days of the industry, the physical condition of superphosphate was, in general, notoriously poor. The product was usually damp, excessively high in free acid, had a pronounced tendency to cake and harden in the bag, and was difficult to distribute uniformly in the field. Today, these undesirable properties have been largely overcome with little or no increase in the cost of the material to the farmer. The work done in recent years on the production of granular superphosphate is of special importance.[5] Economical methods of granulating superphosphate have been developed, and the domestic production of this type of material probably exceeded 150,000 tons in 1939. Granulation greatly improves the drillability of superphosphate and facilitates its uniform distribution in the field, prevents losses when the fertilizer is applied on windy days, and reduces caking of the material in the bag. There is some evidence that granulation improves the

[4] Mehring, A. L., Fertilizer Review **14**, No. 1, 3, 11-13 (1939); Mehring, A. L., Deming, L. S., and Willett, H., Natl. Fertilizer Assoc., 86 pp. (1940).

[5] Hardesty, J. O., Ross, W. H., and Jacob, K. D., Am. Fertilizer **92**, No. 7, 5-8, 24, 26 (1940); Mackall, J. N., and Shoeld, M., Chem. & Met. Eng. **47**, 102-5 (1940).

plant utilization of the phosphorus of superphosphate applied to soils of high phosphorus-fixing power.[6]

Many improvements have been made in the equipment for handling the raw materials and product. Modern mechanical dens of the Sturtevant, Svenska, Broadfield and other types have been installed in many plants, and in most of the other plants the dens are now discharged by means of power shovels, overhead cranes, or other types of mechanical excavators. These machines have largely replaced manual labor in the performance of an exceedingly disagreeable task, one of the most disagreeable in the entire chemical industry. Furthermore, well-kept buildings of steel and concrete are gradually replacing the old wooden structures that were often an eye-sore to the community.

Despite the fact that ordinary superphosphate contains not more than 22 per cent of available P_2O_5 and is, therefore, classed as a low-analysis phosphate, the cost of the raw materials and the simplicity of the manufacturing process are such that, as yet, no other chemically processed phosphate can, in general, compete with it on the basis of cost of production per unit of available P_2O_5 in equally well-managed plants in a given locality. Since, however, bagging, handling and transportation costs per unit of P_2O_5 are higher for superphosphate than for a more concentrated material such as double superphosphate, the advantage of the lower manufacturing cost of the superphosphate, as reflected in the final cost of a unit of P_2O_5 to the farmer, decreases, and may even disappear, with increase in the shipping distance. Nevertheless, there is reason to believe that ordinary superphosphate will continue to supply a very considerable portion of this country's agricultural phosphorus requirements for many years to come.

Double Superphosphate

The term "double superphosphate" refers to the material, containing 40 to 50 per cent of available P_2O_5, made by treating phosphate rock with phosphoric acid. It is synonymous with the terms "triple superphosphate" and "treble superphosphate."

Although sporadic attempts to manufacture double superphosphate in the United States were made in earlier years, the domestic industry was not placed on a permanent basis until 1907. In that year, the Virginia-Carolina Chemical Corporation commenced production of double superphosphate at Charleston, South Carolina, and this plant is still in operation.

[6] Nordengren, S., and Lehrecke, H., Am. Fertilizer 93, No. 1, 5-7, 24, 26; No. 2, 10-11, 22 (1940).

The domestic output of double superphosphate is now distributed among eight plants, of which four (including the Tennessee Valley Authority) are located in Tennessee, two in Florida, and one each in Montana and South Carolina. In the period beginning with 1907, small quantities of double superphosphate were produced at various times by four plants that are no longer in operation.

The total production of double superphosphate[7] gradually increased from 1,800 short tons in 1907 to 95,198 tons in 1930 and then dropped to 24,192 tons in 1932. Beginning in 1934 the production increased rapidly to 187,670 tons in 1938, and this figure is known to have been exceeded in 1939.

Two factors are responsible to a considerable extent for the rapid increase in production during the last six years, namely, (1) the manufacture of double superphosphate by the Tennessee Valley Authority at Wilson Dam, Alabama, and the free distribution of this material to groups of farmers, principally in the Tennessee Valley region, for testing and demonstration purposes, and (2) the distribution of double superphosphate to farmers by the Agricultural Adjustment Administration in lieu of cash benefit payments for the growing of soil-conserving crops. Data on the production and distribution of double superphosphate by the Tennessee Valley Authority are given in

Table 1

Production and Distribution of Double Superphosphate by the Tennessee Valley Authority

(Data from the annual reports of the Tennessee Valley Authority)

	Double Superphosphate		
Year[1]	Produced Short Tons	Distributed Directly to Farmers Short Tons	Supplied to AAA Short Tons
1935.....	19,210	1,986	.....
1936.....	28,960	29,198	.....
1937.....	34,000	21,647	17,183
1938.....	45,759	13,854	26,203
1939.....	69,000	18,356	50,671
Total.....	196,929	85,041	94,057

[1] Year ending June 30 of year stated.

Table 1. Table 2 shows the distribution of double superphosphate by the Agricultural Adjustment Administration.

Inasmuch as double superphosphate contains 40 to 50 per cent of available P_2O_5, as compared with only 16 to 22 per cent in ordinary superphosphate, it is evident that the more highly concentrated material has a distinct advantage in the matter of bagging, handling and transportation costs per unit of P_2O_5. This

[7] Mehring, A. L., Unpublished data.

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THE AMERICAN FERTILIZER

ESTABLISHED 1894

PUBLISHED EVERY OTHER SATURDAY BY WARE BROS. COMPANY
1330 VINE STREET, PHILADELPHIA, PA.

A MAGAZINE INTERNATIONAL IN SCOPE AND CIRCULATION DEVOTED EXCLUSIVELY TO THE COMMERCIAL FERTILIZER INDUSTRY AND ITS ALLIED INDUSTRIES

PIONEER JOURNAL OF THE FERTILIZER INDUSTRY

WARE BROS. COMPANY
PUBLISHERS

1330 VINE STREET PHILADELPHIA, PA.

A. A. WARE, EDITOR

ANNUAL SUBSCRIPTION RATES

U. S. and its possessions, also Cuba and Panama.....$3.00
Canada and Mexico..... 4.00
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Single Copy..... .25
Back Numbers..... .50

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October Cotton Report

A United States cotton crop of 12,741,000 bales is forecast by the Crop Reporting Board of the Agricultural Marketing Service, based on conditions as of October 1, 1940. This is very little change from the forecast as of September 1st, and compares with 11,817,000 bales ginned in 1939, 11,943,000 bales in 1938, and 13,547,000 bales, the 10-year (1929-39) average. The indicated yield per acre for the United States of 250.0 pounds compares with 237.9 pounds in 1939, 235.8 pounds in 1938, and 198.1 pounds, the 10-year (1929-38) average.

Increases during September in the states along the Atlantic Coast, and in Tennessee, Arkansas, and Oklahoma are offset by declines in Alabama, Mississippi, Louisiana, and Texas. Prospects improved by 128,000 bales in the southeastern states from North Carolina to Florida, where below-average rainfall and clear, sunshiny days were favorable for maturing and picking the crop. In Alabama, Mississippi, and Louisiana, the dry period extended over a longer period of time, caused considerable shedding, and reduced prospects

State	Production (Ginnings)[1] 500 lb. gross wt. bales: Average, 1929-38 1,000 bales	1939 Crop 1,000 bales	1940 Crop Indicated Oct. 1 1,000 bales
Missouri	270	437	350
Virginia	37	13	22
N. Carolina	658	457	670
S. Carolina	820	871	925
Georgia	1,175	915	1,082
Florida	34	11	21
Tennessee	472	449	508
Alabama	1,200	785	860
Mississippi	1,619	1,582	1,390
Arkansas	1,283	1,413	1,505
Louisiana	709	745	450
Oklahoma	812	526	765
Texas	3,876	2,846	3,390
New Mexico	99	102	111
Arizona	154	202	197
California	315	443	477
All other	15	20	18
UNITED STATES	13,547	11,817	12,741
Sea Island[2]	...	1.7	5.1
Amer. Egyptian[2]	17	28	38
Lower Calif. (Old Mexico)[3]	42	40	49

[1] Allowances made for interstate movement of seed cotton for ginning.

[2] Included in state and United States totals. Sea Island grown principally in Georgia and Florida. American Egyptian grown principally in Arizona.

[3] Not included in California figures, nor in United States total.

by 171,000 bales. In Arkansas, dry weather during the first three weeks of September hastened maturity, bolls opened rapidly, and prospects were increased by 56,000 bales. Ideal weather in Oklahoma during September brought about an increase there; while in Texas prospects declined 89,000 bales due to below-average precipitation, particularly in the northwest, which caused excessive shedding of forms and small bolls.

Census report shows 3,924,094 running bales (counting round as half bales) ginned from the crop of 1940 prior to October 1st, compared with 6,682,066 for 1939 and 6,577,109 for 1938.

Obituary

MORRIS L. SLUGG

Morris L. Slugg, manager of the Armour Fertilizer Works plant at Chicago Heights, Ill., died at his home in that city on September 23rd, at the age of 59. Death resulted from a cerebral hemorrhage. Mr. Slugg had held the post of plant manager for 16 years, having formerly been manager of the Belfast, Maine, plant of the American Agricultural Chemical Co.

Mr. Slugg took an active part in the civic life of Chicago Heights, including such organizations as the Boy Scouts, the Community Center, the Welfare Association and the Drama Group. He also served on both Chicago Heights board of education—the elementary and Bloom High School boards.

He is survived by his mother, his wife, and three sons.

AUGUST SULPHATE OF AMMONIA

The figures issued by the U. S. Bureau of Mines show that during August 62,254 tons of by-product sulphate of ammonia were produced in this country, an increase of 2.5 per cent over the 60,718 tons produced in July and 22.5 per cent over August, 1939, production of 50,717 tons. During the first 8 months of this year, the total output was 463,679 tons, which was one-third larger than the 347,288 tons manufactured during January-August, 1939.

The production of by-product ammonia liquor was 2,347 tons (NH_3 content) in August, 1940; 2,358 tons in July, 1940; 1,903 tons in August, 1939; 18,190 tons during January-August, 1940; 14,880 tons during January-August, 1939.

CANADIAN FERTILIZER SALES SHOW SLIGHT INCREASE

Sales in Canada of fertilizer materials and of mixed fertilizers, including exports but excluding the export of calcium cyanamid, totaled 512,936 short tons, during the year ended June 30, 1940, compared with 503,570 short tons sold during the preceding 12 months, according to a preliminary statement issued by the Dominion Bureau of Statistics at Ottawa.

Sales consisted of 83,094 tons of fertilizer materials and 239,206 tons of mixtures sold in Canada, a total of 322,300 tons, compared with the previous year's total Canadian sales, which amounted to 334,003 short tons. The export figures were 37,109 tons of mixtures and 154,921 tons of materials, exclusive of calcium cyanamid.

INDIANA FREIGHT INCREASE DENIED

An Indiana intrastate fertilizer rate increase was denied on September 26, 1940, by the Indiana Public Service Commission, which refused any increase over the 10 per cent increase which became effective April 7, 1938. This places the intrastate and interstate rates on the same basis. The carriers had attempted to increase these rates further but were vigorously opposed by N.F.A. Traffic Committee and others, whose contentions were sustained by the Commission.

AUGUST SUPERPHOSPHATE

The output of superphosphate during August, as reported by the National Fertilizer Association, totaled 303,393 tons (including bulk superphosphate, as well as base and mixed goods), compared with 237,728 tons in August, 1939. It was the twelfth consecutive month in which production had been well above the corresponding month of the preceding year. Production was about equally divided between the northern and southern areas, being 158,440 and 144,953 tons respectively.

For the first eight months of the year, the superphosphate output was 2,446,369 tons, an increase of 26 per cent over the January-August period of 1939. Production this year has been only slightly below the banner year of 1937 and it seems quite certain that by the end of the year, this record will be passed.

Stocks on hand were somewhat larger but in spite of this increase they are not particularly large in comparison with the same period of recent years. On August 31st, they totaled 1,348,226 tons; on the same date in 1939 they were 1,197,822 tons.

September Tag Sales

FERTILIZER sales in 17 States in September as indicated by the sale of tax tags amounted to 243,000 tons, according to reports to The National Fertilizer Association. This represented an increase of 9 per cent over last year.

Sales in the South were 8 per cent below August, 1939, but were above 1938. August sales in the South are comparatively small, usually accounting for less than 3 per cent of the annual total. January-September sales this year exceeded the corresponding period of 1939 by 14,000 tons, declines in Virginia, the Carolinas, and Oklahoma being offset by increases in all the other eight States.

September sales volume in the Midwest was substantially above last year, with all five States reporting marked increases. September is usually the peak month in this region, with sales amounting to nearly one-fifth of the annual total. Sales in the first nine months of the year were 16 per cent above last year.

The variation in sales trends in the two areas this year reflects in part differences in farm purchasing power. Total farm cash income in the five mid-western States has been 9 per cent above last year, while total income in the 12 southern States has declined 1 per cent. In addition, the decline in tobacco acreage in Virginia and North Carolina has been an adverse factor in the South.

FERTILIZER TAX TAG SALES

State	September 1940 Per Cent of 1939	September 1940 Tons	September 1939 Tons	September 1938 Tons	January-September 1940 Per Cent of 1939	January-September 1940 Tons	January-September 1939 Tons	January-September 1938 Tons
Virginia	71	38,566	54,263	50,311	92	352,387	383,890	370,272
N. Carolina	84	20,620	24,439	19,433	88	996,445	1,133,394	1,022,979
S. Carolina	80	4,910	6,130	6,781	100	643,484	645,044	633,970
Georgia	65	3,456	5,310	986	107	718,119	671,512	701,269
Florida	114	47,703	41,999	36,741	111	382,364	345,485	345,341
Alabama	230	4,250	1,850	2,950	103	566,300	549,150	524,950
Mississippi	...	1,000	0	1,200	106	294,295	277,846	299,836
Tennessee	537	6,018	1,120	7,274	110	129,891	117,799	121,251
Arkansas	80	200	250	650	143	93,950	65,622	63,500
Louisiana	78	8,900	11,460	7,280	104	142,431	137,188	132,502
Texas	85	6,258	7,328	5,676	124	109,839	88,337	77,798
Oklahoma	286	755	264	775	99	6,608	6,667	7,855
Total South	92	142,636	154,413	140,057	100	4,436,113	4,421,934	4,301,523
Indiana	160	45,406	28,450	31,006	116	299,350	256,958	233,615
Illinois	278	7,100	2,550	3,380	124	47,760	38,637	38,792
Kentucky	117	10,695	9,123	8,808	103	114,884	111,229	106,356
Missouri	132	29,019	22,064	32,986	132	84,599	64,081	67,951
Kansas	147	7,988	5,440	10,455	119	16,671	14,066	17,917
Total Midwest	148	100,208	67,627	86,635	116	563,264	484,971	464,631
Grand Total	109	242,844	222,040	226,692	102	4,999,377	4,906,905	4,766,154

BRADLEY & BAKER

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FERTILIZER MATERIALS MARKET

NEW YORK

Buying Interest Low but Prices Maintained. Bagged Nitrate of Soda Advances. Increased Cost of Sulphuric Acid May Cause Rise in Superphosphate Prices.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, October 8, 1940.

In spite of the fact that buying interest in the raw fertilizer materials market is at an absolute minimum, most materials are maintained at previously reported prices.

The only important development to be noted during the past two weeks is the announcement of a new price schedule by the nitrate of soda people to apply for shipment from October 1, 1940 to and including June 30, 1941; this shows an increase of 40 cents per ton over previous prices on bagged material.

At this time the export market is unusually quiet, due mainly to the increasing difficulties in making shipments to most parts of the world.

Nitrate of Soda

New schedule prevails at $29.40 per ton in 100-lb. bags, $28.70 in 200-lb. bags and $27.00 in bulk, f.o.b. port warehouse. Supplies of this material continue to be sufficient.

Sulphate of Ammonia

Demand is still in excess of supply. Domestic price remains unchanged at $28.00 per ton in bulk, usual Atlantic and Gulf Ports. Some export interest remains at prices ranging from $36.00 to $38.00, material packed in single bags, f.a.s. ports. There is considerable demand for shipment to the Far East, which cannot be fulfilled.

Superphosphate

Ordinary superphosphate is unchanged and this market remains strong. Due to the increased cost of sulphuric acid as a result of heavy demand from the war industries, it is expected that this increased acid cost will be reflected in superphosphate prices in the near future. Considerable export inquiry still exists for superphosphate, but financing difficulties have retarded actual business. Triple superphosphate continues to be very tight.

Potash

Price absolutely firm at schedule. The recent importation of 5,200 tons of Spanish potash, and the possibility of further supplies from this source, tend to ease the market. It is understood that a new potash producing company in New Mexico will start shipments to the trade some time in October. A sizeable export demand exists from Britain and British possessions, but nothing has been booked as yet.

Dried Blood

Buying activity very small with local domestic production being quoted at $2.50 ($3.04 per unit N) and South American material offered at around $2.60 ($3.16 per unit N), per unit.

Tankage

Demand is at a minimum and domestic material rules easy at $2.40 ($2.91½ per unit N) and 10 cents. According to grade, South American productions are being offered from $2.75 to $2.90 ($3.34½ to $3.52½ per unit N) and 10 cents.

Nitrogenous Material

Very dull and no new business has been reported during the past two weeks. Price remains strictly nominal on previous basis.

Bone Meal

Offerings of this material are few and far between, but South American 4½ and 50 per cent grade can be bought at around $31.00, c.i.f.

Fish Scrap

No new bookings of scrap are to be noted. Menhaden meal is still being quoted at $47.00, Baltimore basis.

Soya Bean Meal

Crushers are now receiving new crop beans, and with a large output of meal in the offing,

FERTILIZER MATERIALS

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PHOSPHATE ROCK
SUPERPHOSPHATE
DOUBLE SUPERPHOSPHATE
NITRATE *of* SODA
SULPHURIC ACID
SULPHATE *of* AMMONIA
BONE MEALS
POTASH SALTS
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Norfolk, Va.
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San Juan, P. R.
Sandusky, Ohio
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the price structure has weakened. Bookings can be made for November/forward $18.50 per ton in bulk, f.o.b. Decatur, Illinois; which price is equivalent to $26.60 delivered New England rate points or $26.80 delivered New York area.

BALTIMORE

Little Buying of Materials at Present. Advance in Price of Bagged Nitrate. Sulphate of Ammonia Still Scarce.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, October 8, 1940.

With the exception of slight revision in price on nitrate of soda in bags, the market on raw materials during the past few weeks was practically without feature. The fall shipping season is now on, but no new interest is being displayed in materials for early delivery, as manufacturers have ample stocks to take care of current requirements.

Ammoniates.—Tankage and blood for feeding purposes remain unchanged at $2.80 to $2.90 per unit of nitrogen for tankage and $3.02 for South American blood, with offerings somewhat more plentiful, but very little buying interest is being shown. The New York market on blood has eased off during the past few days, and is now in the neighborhood of about $2.82 per unit of nitrogen, but this situation may only be temporary.

Nitrogenous Material.—The demand continues exceptionally light and with the elimination of the foreign product, goods of domestic manufacture should be higher, but still continue to be quoted at $2.55 to $2.65 per unit of nitrogen, f.o.b. Baltimore.

Sulphate of Ammonia.—This material continues scarce, and practically no manufacturers have been able to cover for their entire requirements for the coming spring season. While the nominal market is $28.00 per ton in bulk, there is none obtainable at this figure. The export market is in the neighborhood of $39.00 per ton, in bags, f.a.s. Baltimore.

Nitrate of Soda.—Domestic manufacturers recently published prices for October and forward shipment in bags at an advance of only 40 cents per ton in 100-lb. bags, making price $29.40 ex port warehouse, which figure was promptly met by importers of the Chilean product. With the scarcity of sulphate of ammonia, it is anticipated that there will be somewhat of an increased demand for nitrate during the coming spring season.

Fish Scrap.—The catch has recently improved somewhat, but the season will soon be drawing to a close, and the market continues firm at $3.75½ per unit of nitrogen and 10 cents per unit of B.P.L., f.o.b. fish factories, for shipment "if and when made" and is still out of line with the market on other protein feeding materials. For this reason very little interest is being manifested in further supplies at the present time, in spite of slowing up in arrivals of Japanese sardine meal, of which there is quite a heavy stock in store in this country at the present time.

Superphosphate.—There is no change in the market and producers continue to quote run-of-pile at $8.00 per ton of 2,000 lb., basis 16 per cent, and flat 16 per cent grade at $8.50 per ton of 2,000 lb., both in bulk, f.o.b. sellers' works, Baltimore.

Bone Meal.—The market on both raw and steamed bone is in the doldrums, as the fall shipping season has not developed any new interest, and comparative prices of bone products are gradually decreasing the demand. The nominal market on 4½ and 47 per cent South American raw bone meal is unchanged at $31.00 to $32.00 per ton, while 3 and 50 per cent domestic steamed bone ranges from $32.00 to $34.00, according to mechanical condition, f.o.b. Baltimore.

Manufacturers' Sales Agents for **DOMESTIC**

Sulphate of Ammonia

Ammonia Liquor :: Anhydrous Ammonia

HYDROCARBON PRODUCTS CO., INC.

500 Fifth Avenue, New York

NATURAL

Chilean

Nitrate of Soda

Old Style and Champion

Both Guaranteed

16% NITROGEN

Valuable not only as a source of nitrogen, but also to help maintain the supply of other plant food elements *naturally* blended with it.

Natural Chilean Nitrate of Soda is the only natural nitrate in the world. It's *always reliable.*

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RALEIGH, N. C. ATLANTA, GA. JACKSON, MISS.

MONTGOMERY, ALA. COLUMBIA, S. C.

SHREVEPORT, LA. LOS ANGELES, CALIF.

Potash.—There is no activity in this material, but it is anticipated that, with stocks on hand and domestic productions, there will be ample to cover manufacturers for their normal requirements. No changes are indicated in the basic price of 53½ cents per unit in the form of muriate.

Bags.—The burlap market is again slightly higher and figures about $113.50 per thousand, basis 40 cut 54 in., plain, 10-oz., delivered Baltimore.

CHICAGO

Fertilizer Material Market Quiet but Sellers Hopeful. Feed Market Dull but Expected to Improve.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, October 7, 1940.

Though slight, an improvement is to be noted in the western organic market. True no sales of consequence have been made, but sellers are encouraged in their belief, wishful or otherwise, that demand will be sufficient to deplete their rather small stocks. Prices, therefore, remain fairly firm.

The feed situation at present is dull. Movement of finished goods has been slow, though with coming cold weather demand should increase.

Nominal prices are as follows: High grade ground fertilizer tankage, $2.00 to $2.25 ($2.43 to $2.73½ per unit N) and 10 cents; standard grades crushed feeding tankage, $2.50 to $2.55 ($3.04 to $3.10 per unit N) and 10 cents; blood, $2.65 to $2.75 ($3.22 to $3.34½ per unit N); dry rendered tankage, 52½ to 57½ cents per unit of protein Chicago basis.

TENNESSEE PHOSPHATE

Lack of Water Still Hampers Mining and Washing Operations. Heavy Shipment of Ground Rock During September.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., October 7, 1940.

Though this section had one good rain in the past two weeks, it was not enough to really repair the ravages of the extreme drought from which we have suffered. Very few, if any, plants have enough water to operate their washing units, but fortunately most of the ones thus unfavorably affected have quite considerable stocks of washed sand and lump in wet storage, so that so far there has been no interference with actual production and shipping ability.

HIGRADE MURIATE OF POTASH
62/63% K_2O
Also 50% K_2O Grade
MANURE SALTS
Approximately 30% K_2O

SUNSHINE STATE POTASH
A PRODUCT OF NEW MEXICO U.S.A.

A NEW call has gone out to the American potash industry! Foreign supplies of this essential element are virtually cut off. Domestic producers must contribute even greater quantities of potash to safeguard this nation's agricultural and chemical requirements.

The United States Potash Company is geared to do its part in the emergency. Ten years ago this Company sank the first shaft of its mine near Carlsbad, New Mexico. Since then, it has worked consistently to free the United States from dependence upon foreign countries for its supply of potash. To meet today's greater need, our operations are keyed to maximum production. Throughout mine and plant, mining and refining equipment is keeping pace with the latest mechanical developments. A skilled and loyal personnel assures the highest peak of operating efficiency. Conscious of our increased responsibility, we pledge ourselves to the task of striving to assure the United States for all time of sufficient domestic supplies of potash.

UNITED STATES POTASH COMPANY, INC., 30 ROCKEFELLER PLAZA, NEW YORK, N. Y.

This surplus of wet storage product is customarily laid in against the advent of unfavorable mining weather likely to set in from November 15th on, so the effect on ability to meet unexpected drafts on shipping capacity will come in December to March, unless unusually good mining weather with restored water for washing operations holds through most of the early winter season.

Increased heavy movement of elementary phosphorus packed in small drums is noted from the furnace plants in this area, and while nothing is made public as to its actual use, it is obvious what a marvellously destructive and effective incendiary bomb could be made from this phosphorus, with a percussion cartridge to explode the container when it strikes and scatter the phosphorus on the structure being bombed, where mere exposure to the air would cause it to burst into flame with terrible effect on people or animals touched by it.

September every year for the past forty three years has been the largest month of the year for shipments of ground phosphate rock to farmers for direct application, except in 1938, when March was the largest, because the ten per cent advance of freight rates, effective March 28th of that year caused over half or normal April shipments to be made in March. The month of September, 1940, witnessed the largest shipments of rock phosphate to farmers since September, 1930, being over 15 per cent larger than for September, 1939.

ATLANTA

Market Quiet with No Price Changes and Only Routine Business Passing.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, October 8, 1940.

The market on all fertilizer materials has been very quiet during the last ten days or two weeks with no major changes in price being reflected in any of the markets. There is, of course, certain volume of trading going on all the time in various materials but it might be termed routine business and does not indicate any unusual activity.

The markets generally are as follows:

Tankage.—Imported, $2.60 ($3.16 per unit N) and 10 cents c.i.f.

Blood.—Imported, $2.60 ($3.16 per unit N), c.i.f.

Fish Scrap.—$3.25 ($3.95 per unit N) and 10 cents, Chesapeake Bay.

Sulphate of Ammonia.—Still tight but no change in price.

Nitrate of Soda.—Unchanged.

Cottonseed Meal.—Prime 8 per cent, $21.00 to $21.50, basis f.o.b. Memphis.

Steam Bone Meal.—3 and 50 per cent, $31.50, c.i.f.

Raw Bone Meal.—4½ and 45 per cent, $31.50, c.i.f.

CLASSIFIED ADVERTISEMENTS

Advertisements for sale of plants, machinery, etc., and for help and employment, in this column, same type as now used, 60 cents per line, each insertion.

POSITION WANTED

AFTER a period of idleness forced by poor health, an all-round fertilizer man is again in fine condition and is anxious to get busy. Technically and practically qualified in the manufacturing end of the business. More than twenty years a successful Superintendent. Sulphuric acid production a specialty. Capable, attentive, resourceful, active, sober. Any proposition considered. Address "475," care THE AMERICAN FERTILIZER, Philadelphia, Pa.

PULVERIZED
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LIMESTONE
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MAGNESIUM LIMESTONE
"It's a Dolomite"
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THE figuring of fertilizer formulas requires more than a mere listing of required amounts of the various carriers of the three major plant foods that make up a complete fertilizer.

Production of quality fertilizers involves a number of other important considerations, such as availability of the plant foods, resistance to leaching, equivalent acidity or basicity, and physical condition or drillability of the finished fertilizer—to name only a few.

Urea-Ammonia Liquors and "Uramon" deserve your careful consideration as carriers of nitrogen to be used in your mixed fertilizers and top-dressers. When you figure your fertilizer formulas, keep in mind that these materials supply nitrogen which is (1) completely available; (2) highly resistant to leaching; and (3) low in equivalent acidity.

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"URAMON" Fertilizer Compound
Reg. U. S. Pat. Off.
(42% *Urea Nitrogen*)

Urea-Ammonia Liquors
(*Urea and Ammonia Nitrogen*)

NEW AND OLD METHODS OF PROCESSING PHOSPHATE

(Continued from page 9)

advantage increases with the distance from the point of production, with the result that, despite its higher cost of manufacture, farmers in many localities can obtain double superphosphate at a unit cost lower than that of ordinary superphosphate. Contrary to the argument that is sometimes advanced against its use, double superphosphate can be applied to crops as evenly and effectively as can ordinary superphosphate.

Table 2

Double Superphosphate Distributed to Farmers by the Agricultural Adjustment Administration

State	Program Year[1] 1937	1938	1939[2]
Alabama	179	1,786	3,572
Arkansas	36	269	3,772
Connecticut	....	279	769
Florida	62	67	....
Georgia	21	....	192
Indiana	....	....	224
Kentucky	18,582	33,263	37,968
Louisiana	....	....	22
Maine	....	1,344	4,760
Maryland	....	44	103
Massachusetts	....	....	1,785
Mississippi	....	....	37
New Hampshire	....	779	4,108
North Carolina	370	1,027	3,514
Ohio	....	....	393
Oklahoma	79	61	127
Oregon	....	....	2,444
Pennsylvania	....	300	....
Rhode Island	....	....	206
South Carolina	....	....	26
Tennessee	5,205	11,095	18,179
Texas	31	31	29
Vermont	....	5,175	4,748
Virginia	518	3,636	16,195
Washington	....	....	1,600
West Virginia	....	7,705	16,488
Total, 26 States	25,083	66,861	121,261

[1] For a few crops the program year begins on October 1st or November 1st, but for the majority it begins on January 1st.

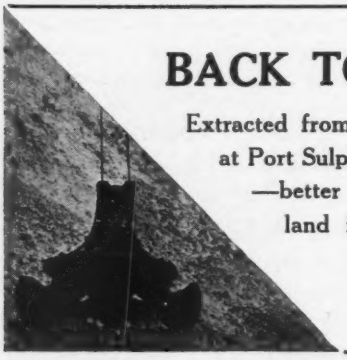
[2] Preliminary figures.

Double superphosphate usually contains 17 to 22 per cent of CaO and 2 to 6 per cent of SO_3, as compared with 27 to 30 per cent and 29 to 31 per cent, respectively, in ordinary superphosphate. Thus, there is associated with a given quantity of phosphorus in double superphosphate only about 27 per cent as much calcium and 5 per cent as much sulphur as is associated with the same quantity of phosphorus in ordinary superphosphate. Calcium and sulphur are necessary for the growth of plants, and where either or both of these elements are deficient in the soil ordinary superphosphate would appear to be a more desirable fertilizer than double superphosphate. It should be borne in mind, however, that the farmer purchases both types of superphosphates primarily for their phosphorus content, and that his choice between the two should be governed principally by the price of the phosphorus. If phosphorus in the form of double superphosphate can be obtained at a lower price than that in the form of ordinary superphosphate, it doubtless would be more economical in many cases to purchase the more highly concentrated phosphate and to utilize local materials for supplying such additional quantities of calcium and sulphur as might be needed.

In numerous comparative tests made in the United States and other countries, the crop yields obtained with double superphosphate have been nearly the same as those with ordinary superphosphate. The average results of tests made in the seven Tennessee Valley states (Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee and Virginia) during the period 1935 to 1938 are given in Table 3.

Phosphoric Acid

Although liquid phosphoric acid is used as a fertilizer only to a very limited extent, its



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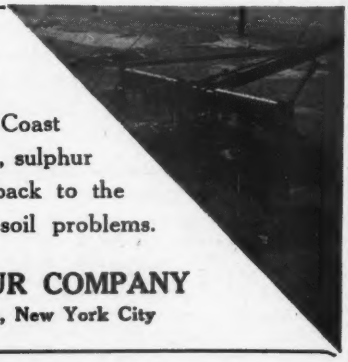
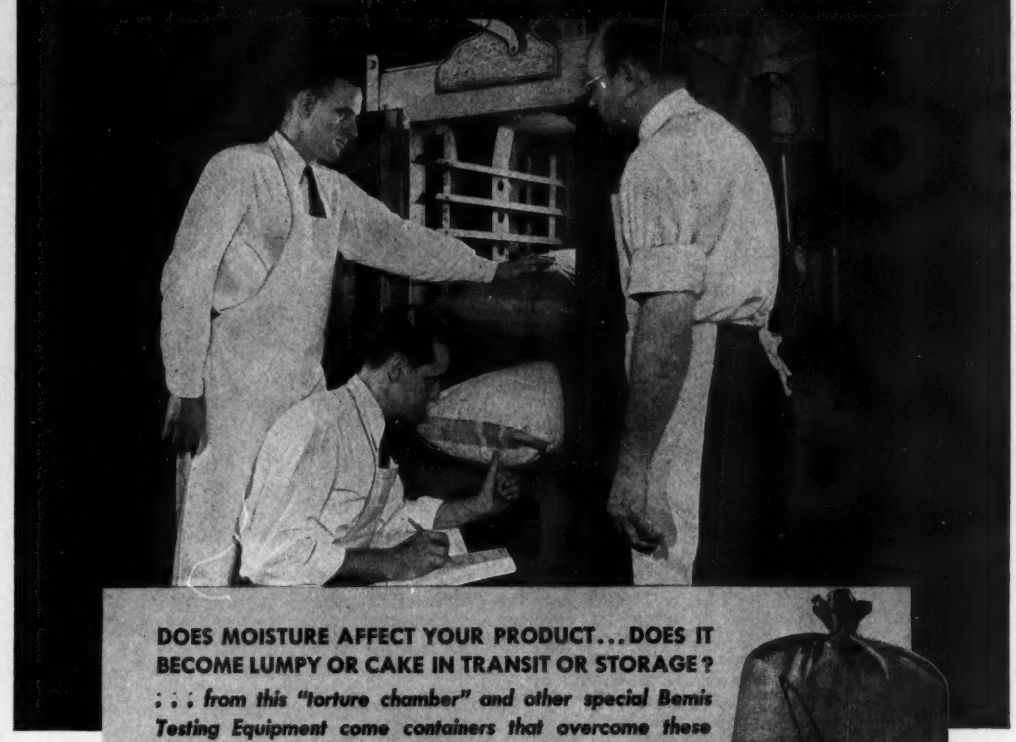


WE'RE APT TO PUT YOUR PRODUCT INTO OUR TORTURE CHAMBER



DOES MOISTURE AFFECT YOUR PRODUCT... DOES IT BECOME LUMPY OR CAKE IN TRANSIT OR STORAGE?

. . . from this "torture chamber" and other special Bemis Testing Equipment come containers that overcome these and other shipping hazards.

Through Research, BEMIS helps your products Serve and Sell better . . .

To makers of special fertilizers, the Bemis Shipping Research Laboratory has brought thousands of dollars in extra profits through increasing the efficiency of shipping containers. Products are arriving in better condition, customers are better satisfied, sales are up.

In this unique laboratory, chemists and shipping research men duplicate actual shipping and storage conditions. Bag materials and constructions are experimented with until the right combination to give your product increased shipping efficiency is discovered.

It will pay you to check with Bemis today. Let us show you at what small cost you can secure "Laboratory-Prescribed" Bemis Waterproof Bags.

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WATERPROOF DEPARTMENT

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production is necessary for the manufacture of such important fertilizer materials as double superphosphate and the ammonium phosphates. Two types of processes are in common use for the production of phosphoric acid, namely, (1) the wet process,[8] which involves the treatment of phosphate rock with sulphuric acid and the separation of the phosphoric acid from the precipitated calcium sulphate by decantation and (or) filtration, and (2) the furnace process,[9] which involves the smelting of a mixture of phosphate rock, silica and coke in electric or blast furnaces, whereby the phosphorus is volatilized and either is converted directly into phosphoric acid or is condensed and subsequently converted into acid in a separate operation.

The electric furnace process has been in operation in this country for many years, but only since 1920 has it played an important part in the phosphate chemical industry. Principally because of the strength and purity of the acid obtainable, this process has largely displaced the wet process in the production of phosphoric acid for the manufacture of phosphate chemicals. The Tennessee Valley Authority, Wilson Dam, Alabama, and the Phosphate Mining Co., Nichols, Florida, use electric furnace acid in the manufacture of double superphosphate.

In 1929, commercial production of phosphoric acid by the blast furnace process was started at Nashville, Tennessee, by the Victor Chemical Works. Although the output of this plant has been employed principally in the manufacture of phosphate chemicals, some of the acid has been used in the production of double superphosphate. As regards the relative merits and economy of electric and blast furnaces for phosphorus and phosphoric acid manufacture, it would appear significant that the Victor Chemical Works also built an electric furnace plant at Mt. Pleasant, Tennessee, in 1937 which was enlarged recently while operation of the blast furnace plant was suspended.

Despite the progress that has been made in reducing the cost of furnace-made acid, it is still a debatable question whether such acid can compete, in general, with wet-process acid in the manufacture of fertilizer. The furnace process has the advantage that it is able to use lower grades of rock and can readily produce acid of any desired concentration. The wet process has the advantage of lower installation cost; it requires fewer skilled workmen, and it is better adapted to periodic operation. The wet process has the further advantage that with little additional equipment the plant can produce both ordinary superphosphate and double superphosphate, the first for distribution in nearby areas and the latter for shipment to more distant points. These advantages, or disadvantages are inherent in the processes, regardless of plant location. On the other hand, a very important factor, one that is inseparably associated with plant location, is the cost of energy, whether it be in the form of electricity, fuel, or sulphuric acid. This may well be the deciding factor in the choice of location or in the choice of process for a particular location.

Three plants in this country, including the Tennessee Valley Authority, use furnace-made phosphoric acid in the manufacture of double superphosphate, whereas five plants use wet-process acid. The principal, if not the only, domestic manufacturer of fertilizer-grade ammonium phosphate also uses wet-process acid. The output of double superphosphate by the Tennessee Valley Authority accounts for approximately 30 per cent of the total domestic production. Of the remainder, only about 10 per cent is manufactured with furnace-made acid.

Table 3

Consolidated Relative Average Yields Produced by Double Superphosphate in Comparison with no Fertilizer, no Phosphate, and Ordinary 16 Per Cent or 20 Per Cent Superphosphate, on Unlimed and Limed Soils

[Data from Ball, C. R., "A Study of the Work of the Land-Grant Colleges in the Tennessee Valley Area in Cooperation with the Tennessee Valley Authority," 76 pp. (1939).]

Treatment	Unlimed		Limed	
	Number of Tests[1]	Relative Yield	Number of Tests[1]	Relative Yield
No fertilizer	650	64.5	200	77.5
N and K only	3,654	79.9	984	81.4
16% or 20% superphosphate with N and K	3,943	100.0	1,432	111.0
43% double superphosphate with N and K	3,138	98.0	2,920	106.1
43% double superphosphate with N, K and sulphur	1,292	100.9	No data	

[1] Field tests with a variety of row and rotation crops.

[8] Larison, E. L., Ind. Eng. Chem. **21**, 1172-5 (1929); Weber, W. C., Chem. & Met. Eng. **39**, 659-62 (1932).

[9] Curtis, H. A., Miller, A. M., and Newton, R. H., Chem. & Met. Eng. **45**, 116-20, 193-7 (1938); Kirkpatrick, S. D., *ibid.* **44**, 644-50 (1937); Easterwood, H. W., *ibid.* **40**, 283-7 (1933); Carothers, J. N., Trans. Electrochem. Soc. **73**, 42-6 (1938).

(To be continued in the next issue)

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We manufacture all grades of Commercial Fertilizers, Superphosphate, Agrinite Tankage, Bone Black, Bone Black Pigments (Cosmic Black), Dicalcium Phosphate, Monocalcium Phosphate, Gelatin, Glue, Ground Limestone, Crushed Stone, Agricultural Insecticides (including Pyrox, Arsenate of Lead, Calcium Arsenate, etc.), Trisodium and Disodium Phosphate, Phosphorus, Phosphoric Acid, Sulphuric Acid, Salt Cake; and we are importers and/or dealers in Nitrate of Soda, Cyanamid, Potash Salts, Sulphate of Ammonia, Raw Bone Meal, Steamed Bone Meal, Sheep and Goat Manure, Fish, Blood and Tin-Tetrachloride. We mine and sell all grades of Florida Pebble Phosphate Rock.

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Charleston, S. C.	Greensboro, N. C.	Norfolk, Va.	St. Paul, Minnesota
Cincinnati, Ohio	Henderson, N. C.	No. Weymouth, Mass.	Wilmington, N. C.
Cleveland, Ohio	Houlton, Me.	Pensacola, Fla	Havana, Cuba

AVAILABILITY OF PHOSPHATES

(Continued from page 6)

absorbed, which indicates that care is required in handling Neubauer test material.

Pot cultures in soil or sand in greenhouses have been used extensively and the literature contains a considerable amount of published work. While ostensibly this method attempts to simulate growing conditions in the field, and many investigators have published their data and conclusions in a rather blind belief that this is true, this method has too many pitfalls to be regarded as a reliable basis for recommendations to farmers unless accompanied and supported by chemical analysis or correlated field-plot work. Beginning with ignorance of the effect of length of day and intensity of sunlight in attempting to grow crops in greenhouses in or out of the corresponding season outside, the factors differing from field conditions are such as to vitiate the reliability of the data too frequently. The fact that optimum moisture and temperature conditions are always maintained in pot culture work, when they seldom exist in field practice, is in itself a difference that relegates this method of investigation to that of a supplementary or correlated activity.

As a long-time basis for practical recommendations to farmers, as a reference for checking the correlation of chemical analyses to crop response, as visual evidence to the consumer of fertilizers, and as a means of checking on the effectiveness of commercial plant-food materials and complete fertilizers under the climatic and soil conditions with which the farmer has to contend, field-plot experiments are and probably will continue to be essential to the study of phosphorus availability. As this point the chemist must either turn the problem back to the agronomist and horticulturist, seek their cooperation, or attempt himself to become either an agronomist or horticulturist.

The pitfalls in this method of experimenting are almost innumerable. Even statistical and biometrical analysis of the data will not overcome the effects of soil variation if the expense budget permits too few replications of treatments. Large-scale experiments have tended to show up finally as merely demonstrations.

Much of the data from field plot experiments is contradictory until chemical research is conducted to explain the results, or is correlated to explain the conditions under which the data is obtained.

Nevertheless it is from actual field trials in carefully conducted plot work that much of the information, which is today recognized as the basic principles of our science of plant nutrition, has been obtained. This work, as reported in the literature, can be divided into several types, namely:

1. Rate and method of application studies.
2. The place of phosphate applications in the crop rotation.
3. Comparisons of commercial phosphate materials.
4. Comparisons of phosphorus compounds.
5. Comparison of complete fertilizers in which the phosphorus is present in different combinations.
6. Comparison of physical forms of materials and/or complete fertilizers.

Rates and Methods of Application

This type of work in recent years has demonstrated the advantage of continuous band application of fertilizers to most row-cultivated crops on most soils. The effectiveness of a layer of soil between the fertilizer and the seed in reducing plasmolysis and injury from too high soluble salt concentration has been shown. The importance of a relatively high concentration of phosphorus in the soil solution immediately after transferring plants from the plant-bed to the field has been shown by the published data on the use of "starter" solutions, and by the incorporation of relatively large quantities of superphosphate in the row before transplanting.

All of this type of work, while it can by no means be regarded as complete or completed, is proving very valuable in a practical way to farmers and to the fertilizer industry.

Comparisons of Phosphate Fertilizers

The literature is full of the published results of such comparisons. Some of the work was valuable at the time it was published. Some of it has outlived its usefulness prior to whatever the date of publication was or may be.

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See Page 4

There are so many comparisons of rock phosphate *vs.* superphosphate as to make this type of work seem out of proportion to any possible economic significance of the data. In general, with an adequate moisture supply, on soils high in organic and mineral colloids and in a rotation that supplies liberal quantities of green or stable manure, the crop response from rock phosphate has been profitable, and in some instances equal to that from superphosphate. In many instances the comparison on limed soil was to the disadvantage of rock phosphate, and on unlimed soils the response from either was not sufficient to show a profit on the production of the crop.

There are too few comparisons between the phosphorus materials that are of economic importance such as superphosphate, concentrated superphosphate, mono- and di-ammonium phosphate; mono-, di- and tri-sodium phosphate and potassium phosphate. There are too few comparisons of the different phosphorus compounds that occur in commercial fertilizer materials and in fertilizer mixtures of different methods of formulating, for example, between mono-, di- and tri-calcium phosphate; mono- and di-ammonium phosphate; magnesium-ammonium phosphate; mono- and di-magnesium phosphate; and mono-potassium phosphate.

There are too few comparisons between pulverized and granular phosphate materials, and pulverized and granulated complete fertilizers of similar composition.

There are too few comparisons between so-called standard fertilizer analyses and concentrated analyses, with each grade adjusted to supply the same quantity of minor elements in line with any known deficiencies that may occur on the soil type for the crop being grown.

These comparisons are of immediate and pressing economic importance, either because these types of materials, mixtures or analyses are already competing on the market for the farmer's dollar, or because changing economic and political conditions may affect the actual or potentially economic methods of manufacture, or because a changing emphasis on crops due to the change in markets and the economic problems of the farmer may make the use of some of these materials relatively more important.

There are experiments of this type in progress, and some important and interesting data have been published; but it is still too fragmentary in the main, and too inconclusive in some instances, to place sufficient emphasis on it to make general recommendations for important major crops over wide-spread areas.

Conclusion

Economies in the transportation and handling of concentrated fertilizers, and the desirability of further reducing or eliminating carrier elements of little value, so that the definitely needed quantities of secondary and minor elements can be included without sacrificing concentration of the primary plant-food elements, indicate there is progress to be made in this direction.

Inevitably at some time on some points the plant-food industry will forge ahead of the research organizations; but in general and for the greater part, the industry can find it safe only to manufacture and sell to the farmers such forms of plant-food in materials and mixtures as the research workers have shown to be safe and give an adequate and profitable crop response in those soil areas and on those crops found within each individual manufacturer's sales area.

An active cooperation by the phosphate industry in encouraging the discontinuance of obsolete materials and types of experiments, and the starting and conducting of research with the present economically important forms of phosphorus as well as those which may appear as being potentially on the horizon, should prove profitable to the industry, stimulating to the research worker, and a safeguard to the farmer.

STANDARD WORK WEEK SHORTENED

Beginning October 24, 1940, the maximum workweek, under the Fair Labor Standards Act, becomes forty hours. This means that employees covered by the Act must be paid at a time-and-a-half rate for hours worked in excess of forty in any week. The Act applies to all employees engaged in interstate commerce or in the production of goods for interstate commerce.

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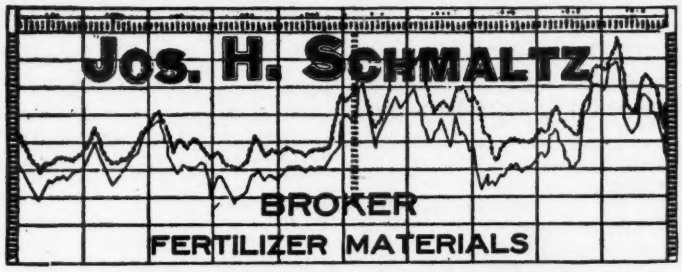

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A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

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For Alphabetical List of Advertisers, see page 33.

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Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

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American Cyanamid Co., New York City.

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Barrett Company, The, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA LIQUOR
Barrett Company, The, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA OXIDATION UNITS
Chemical Construction Corp., New York City.

AMMONIATING EQUIPMENT
Sackett & Sons Co., The A. J., Baltimore, Md.

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Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

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Sackett & Sons Co., The A. J., Baltimore, Md.

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Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.
Fulton Bag & Cotton Mills, Atlanta, Ga.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.
Fulton Bag & Cotton Mills, Atlanta, Ga.

BAGS—Paper
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.
Fulton Bag & Cotton Mills, Atlanta, Ga.

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Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
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Bradley & Baker, New York City.
Huber & Company, New York City.
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Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
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BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
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Huber & Company, New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

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Stedman's Foundry and Mach. Works, Aurora, Ind.

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

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Link-Belt Company, Philadelphia, Chicago.

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ELEVATORS AND CONVEYORS—Portable
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ENGINEERS—Chemical and Industrial
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Fairlie, Andrew M., Atlanta, Ga.
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Stedman's Foundry and Mach. Works, Aurora, Ind.

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Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.

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American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio.
International Agricultural Corp., New York City.
Smith-Rowland Co., Norfolk, Va.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

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Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
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GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
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GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

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Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
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Jeffrey Manufacturing Co., The, Columbus, Ohio.
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MACHINERY—Power Transmission
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.

MACHINERY—Tankage and Fish Scrap
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Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNESIA
California Chemical Co., New York City.

MAGNETS
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE AND CARBONATE
Tennessee Corporation, Atlanta, Ga.

MANGANESE SULPHATE
Tennessee Corportion, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
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American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
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Huber & Company, New York City.
International Agricultural Corp., New York City.
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Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Synthetic Nitrogen Products Co., New York City.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
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Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
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Baker & Bro., H. J., New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCRAPERS—Drag
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Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

SCREENS
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Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
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SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
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Schmaltz, Jos. H., Chicago, Ill.
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Ashcraft-Wilkinson Co., Atlanta, Ga.
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Texas Gulf Sulphur Co., New York City.

SULPHURIC ACID
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.

SULPHURIC ACID—Continued
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Agricultural Corp., New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
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Baker & Bro., H. J., New York City.
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Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
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UREA
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UREA-AMMONIA LIQUOR
Du Pont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
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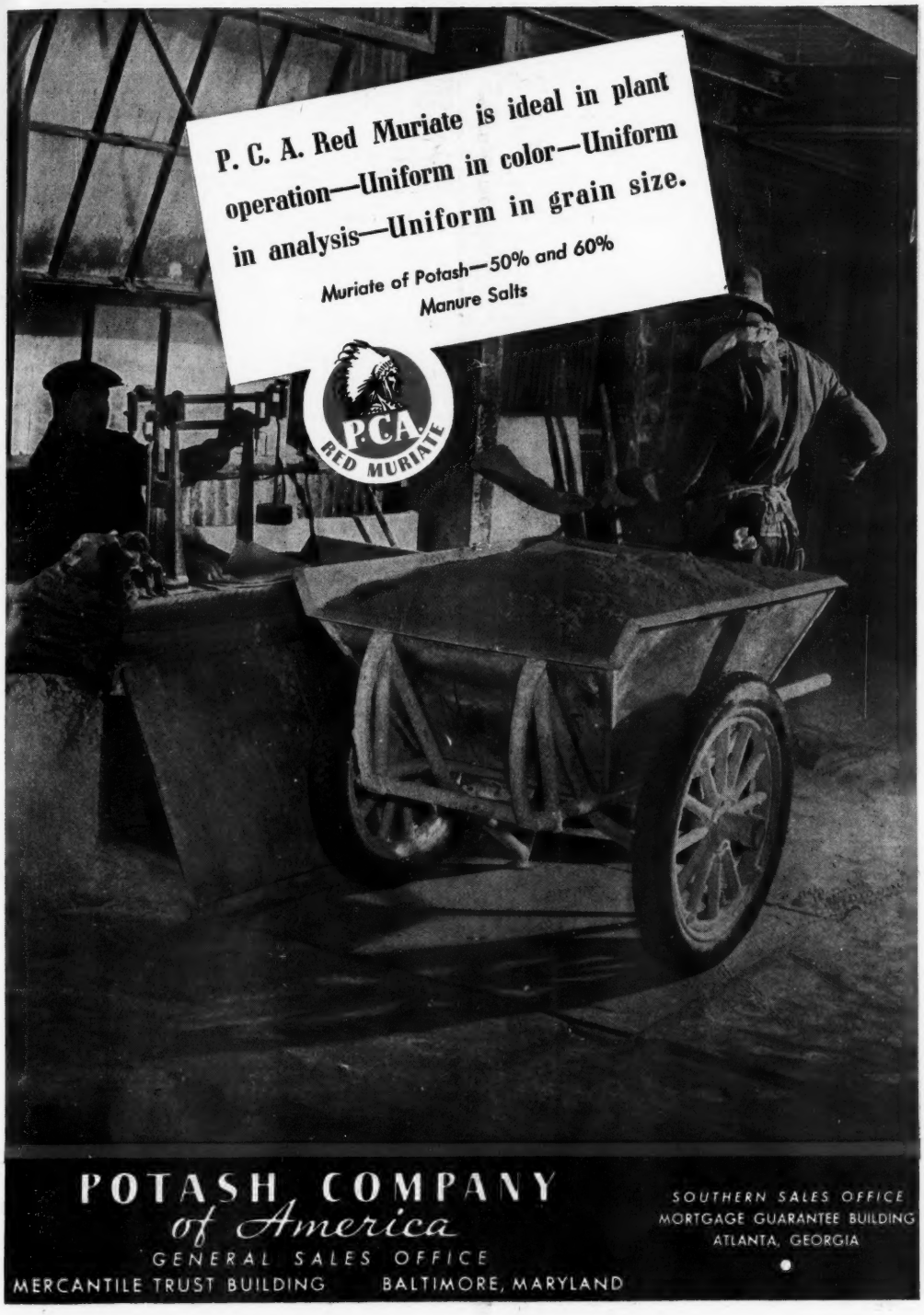
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